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NYLON VELOUR FOR PROTECTION AGAINST PERCUTANEOUS SINUS TRACT FO--ETC(U)
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William M. Witt, Capt, USAF, VC
John W. Burns, Ph.D.
M. Harold Laughlin, Capt, USAF, BSC

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A technique is presented that will avert most sinus tract formation and subsequent infection in chronically instrumented miniature swine. The textured surface of nylon velour fabric, used to alter the outer surface of instrumentation leads, facilitates a mechanical attachment by producing significant tissue response, resulting in excellent interfacing between the fabric and the integument. This technique has greatly facilitated research endeavors with chronically instrumented miniature swine and could lend itself quite readily for use with other laboratory animals.

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NYLON VELOUR FOR PROTECTION AGAINST PERCUTANEOUS SINUS TRACT FORMATION IN INSTRUMENTED SWINE

INTRODUCTION

Chronic instrumentation of laboratory animals has become a mainstay of physiologic research. Since its inception, however, chronic instrumentation has presented investigators with many problems, one of which is sinus tract formation and subsequent infection due to prolonged penetration of the animal's skin by percutaneous leads (Fig. 1).

Figure 1. "Nonveloured" percutaneous leads in a chronically instrumented miniature swine. Sinus tract formation and infection (pus) surrounds the leads where they exit the skin.

Wounds formed by penetration of the integument with instrumentation leads must heal before the body's structural continuity can be restored. Wound healing is a complex mechanism involving fibroplasia and epithelial regeneration as key constituents. Fibroplasia consists of both a collagen phase, which provides tensile strength to the wound, and a granulation phase, which provides protection against wound infection while serving as a nutrient bed supporting reepithelization of the wound (1). During normal epithelial regeneration, a thin layer of epithelial cells migrates inward

from the wound edges until cells of one side meet those of the opposite side. Once the gap has been bridged, the inward migration ceases and thickening of the layer proceeds until epithelization is completed.

Most instrumentation leads used today have a smooth, nonreactive, and impermeable outer surface. This surface is ideal for protecting the instrumentation; however, if the lead is used percutaneously, its outer surface represents a physical barrier to the epithelization of the wound. Although the epithelial cells migrate to the lead and eventually surround it, actual interfacing never occurs. The structural continuity of the skin is never restored, and sinus tract formation and infection usually result. If, on the other hand, the percutaneous portion of the instrumentation has an outer surface that not only protects the lead but also includes a textured surface to facilitate a mechanical attachment, optimal interfacing between integument and lead might be accomplished (Fig. 2) and sinus tract formation averted (Figs. 3 and 4). A technique utilizing velour fabrics to cover chronically implanted transcutaneous Silastic rods was developed by Hall et al. for dogs in 1968 (2) and for dogs, goats, and pigs in 1975 (3). We wished to develop similar methodology for chronic instrumentation and catheterization of miniature swine used in acceleration research at the USAF School of Aerospace Medicine, Brooks AFB, Texas.

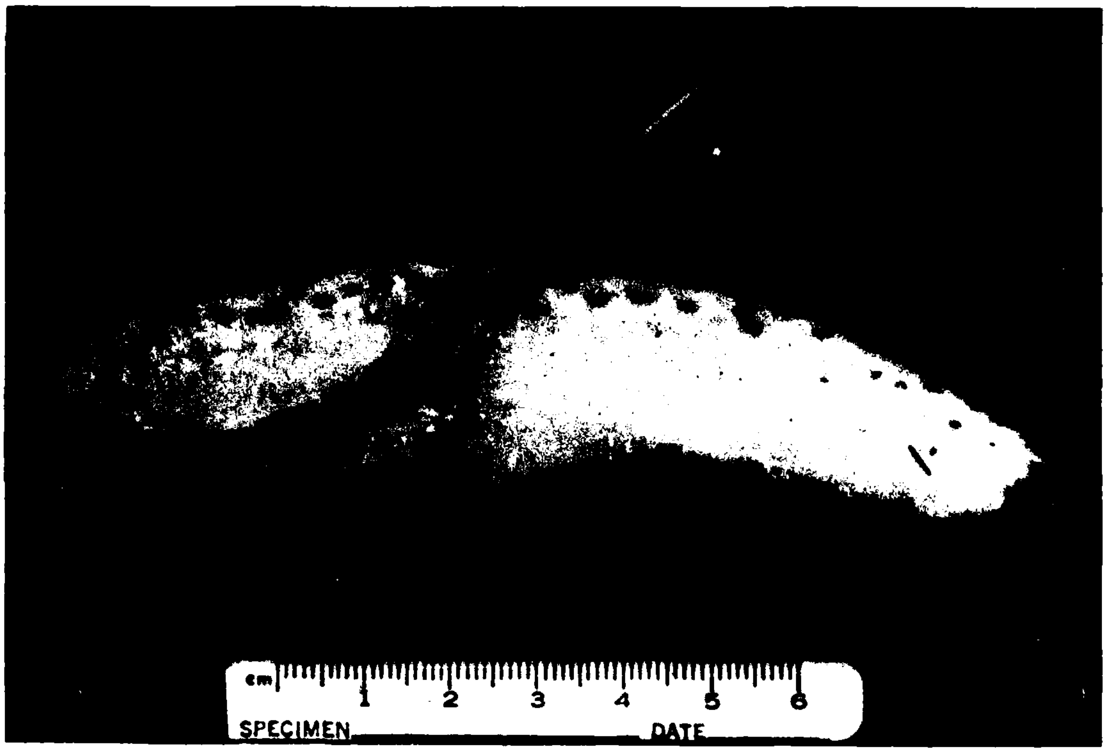

Figure 2. Interfacing between the textured surface of a veloured Silastic catheter and the panniculus adiposus and integument of a miniature swine. The catheter had been in place for approximately 2 months; no evidence of sinus tract formation or infection is seen.

Figure 3. Interfacing between skin and lead in a chronically instrumented miniature swine. No evidence of sinus tract formation or infection is present after approximately 4 months. Hair was clipped from the area and Topazone applied to the site after each study period.

MATERIALS

The fabric[1] we use in the "velour sleeving technique" has been used in the clothing industry for years (3) and is available commercially through many fabric dealers. Silastic adhesive[2] is used to bond the fabric to the instrumentation leads.

METHODS

Sleeving Technique

Velour sleeves can easily be applied to the outer surface of our instrumentation devices (Fig. 5). The sleeve consists of 4-6 inches of nylon velour fabric and is attached to the distal end of an instrumentation lead. The lead must be clean and dry to ensure good adhesion and minimize air pockets when the fabric is cemented to the lead with Silastic adhesive.

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[1]Nylon velour (Webco Mills, Div. of Dan River Inc., New York, N.Y.).
[2]Silastic Medical Adhesive (Dow Corning Corp., Midland, Mich.).

Figure 4. Interfacing between skin and lead in a chronically instrumented baboon illustrates the adaptability of the velour technique to other species of laboratory animals. Instrumentation had been in place for 3 months.

The sleeve should then dry at room temperature for approximately 24 hours; after the drying, excessive fabric and adhesive are trimmed, leaving a clean, neat seam. Prior to implantation, the sleeved instrumentation is sterilized using ethylene oxide. Steam sterilization was unacceptable in our application because of the sensitivity and composition of the electronic instrumentation; however, it would be acceptable for instrumentation not affected by high temperature or pressure, such as Silastic catheters.

Implantation of Leads

After the instrumentation has been secured in its proper location, the leads are passed subcutaneously and exteriorized on the dorsum just anterior to the scapulae. The leads are carefully pulled through the skin until approximately 1-1.5 inches of the sleeves are exposed (Figs. 3 and 4). Each skin wound should be closed with a horizontal mattress suture, using an absorbable suture material. We have found it very advantageous to apply an irritant[3] to the wound to facilitate formation and proliferation of granulation tissue, a necessity if proper interfacing between sleeve and integument is to be achieved.

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[3]Granulex (Dow B. Hickham, Inc., Houston, Tex.).

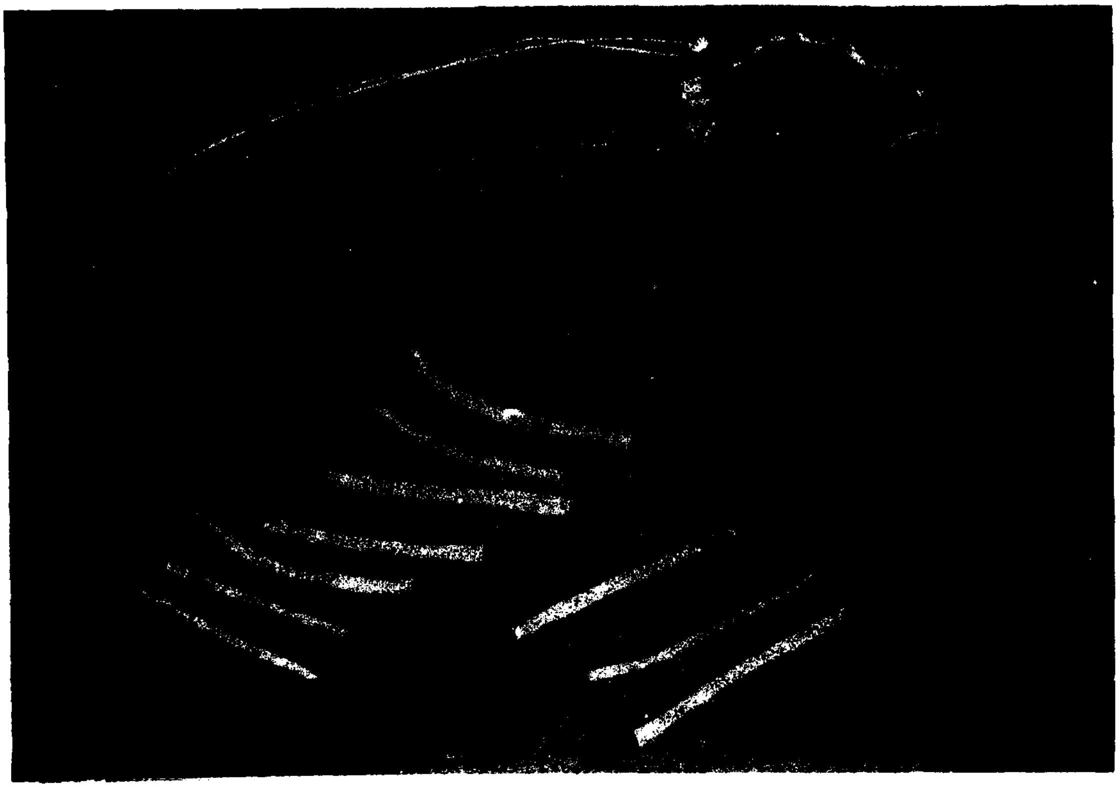

Figure 5. Instrumentation used with the velour sleeving technique includes: A) ultrasonic dimension crystals, B) Zepeda electromagnetic flow transducers, C) Konigsberg pressure transducers, D) Silastic catheters, E) Biotronex electromagnetic flow transducers, F) ECG electrodes, and G) doppler flow transducers. Instrumentation is pictured with velour sleeves in place.

RESULTS AND DISCUSSION

During the past 2 years, approximately 100 miniature swine[4] have been chronically instrumented at the USAF School of Aerospace Medicine for use in various acceleration studies. Depending upon parameters investigated, an animal might have been involved in a study for only 2 weeks or for as long as 10 months; and might have had as few as two or as many as nine percutaneous leads penetrating its skin. In studies such as these, sinus tract formation and infection are chief concerns of the investigator. The use of the velour sleeving technique, along with proper exteriorization of the leads and routine observation and care of the skin wounds, has practically eliminated this problem in our laboratory. Care of the skin wounds entails weekly clipping of hair surrounding the leads and discriminate application of furazolidone[5] after each study period.

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[4]Minipigs (Pitman-Moore strain, Vita Vet Laboratories, Inc., Marion, Ind.).

[5]Topazone (Eaton Veterinary Laboratory, Div. of Morton-Norwich Products, Inc., Norwich, N.Y.).

We contend that the dorsum of the pig, just anterior to the scapulae, is very suitable for lead exteriorization. The panniculus adiposus in this area is relatively thick (1-2 inches) and serves as a rigid support for the sleeved leads. This location makes it virtually impossible for the animals to "get at" their leads; at the same time, the leads are easily accessible for study, observation, and treatment when necessary. This point of exteriorization has worked extremely well in our laboratory and we recommend its use in chronic studies involving instrumented miniature swine.

Although the sleeving technique has greatly reduced our concern over sinus tract formation, it does have a unique, but minor, flaw. We have noticed a "growth phenomenon" exhibited by the velour sleeve if left implanted for several months. This phenomenon was first noted and explained by Hall et al. in 1975. They believe that bonds are formed between the monofilament strands of the nylon velour and certain protein molecules of basal cells surrounding the sleeve, and that these bonds remain throughout the life of the cells. Normal maturation of these basal cells dictates that they eventually migrate to the surface of the skin, and this migration creates a vector force that slowly (approximately 1 mm/mo.) carries the entire implant towards the exterior (3). Because our studies have not called for investigation periods in excess of 10 months, the "growth phenomenon" has been insignificant. It appears as only a minor consideration when we ponder the benefits to be gained by utilizing the technique.

Our research endeavors with chronically instrumented miniature swine have been greatly facilitated by using this sleeving technique. We have also recently applied the technique successfully to chronically instrumented baboons (Fig. 4). We feel that the velour sleeving technique can be utilized in chronic instrumentation studies involving many species of laboratory animals.

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